



Respiration, Muscles and the Internal Environment practice questions

38 questions · 136 marks · mark scheme at the back

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Name

Total / 136

Stages of respiration

Spec 7.1-7.5

A Level only

1 UNIT 5 STYLE [1 mark]

Which statement about substrate-level phosphorylation is correct?

- A. ☐ It needs the electron transport chain and ATP synthase.
- B. ☐ ATP is made by transferring a phosphate group directly from a substrate molecule to ADP.
- C. ☐ It only occurs in the mitochondria.
- D. ☐ It makes most of the ATP in aerobic respiration.

2 UNIT 5 STYLE [5 marks]

Describe the role of glycolysis in respiration.

3 UNIT 5 STYLE [4 marks]

Describe the link reaction.

4 UNIT 5 STYLE

[3 marks]

The table shows the number of molecules of reduced NAD formed in each stage of respiration. Calculate the total number of molecules of reduced NAD formed from one molecule of glucose by glycolysis, the link reaction and the Krebs cycle. Show your working.

Reduced NAD formed	
Stage	Reduced NAD formed
Glycolysis (per glucose)	2
Link reaction (per pyruvate)	1
Krebs cycle (per turn)	3

Answer = ...

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5 UNIT 5 STYLE

[5 marks]

Explain how the electron transport chain and ATP synthase produce ATP in a mitochondrion.

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6 UNIT 5 STYLE

[3 marks]

In a sprinter's muscle, oxygen supply is too low for the electron transport chain to work. Explain why the muscle cells can still make ATP for a short time when pyruvate is converted to lactate.

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[4 marks]

[illegible]

[3 marks]

[illegible]

Spec 7.6-7.8

A Level only

[1 mark]

A. ☐ 0.5

B. ☐ 0.7

C. ☐ 0.9

D. ☐ 1.0

[2 marks]

[illegible]

11 UNIT 5 STYLE

[3 marks]

Explain why the RQ for the respiration of lipid is lower than the RQ for the respiration of carbohydrate.

12 UNIT 5 STYLE

[4 marks]

Describe how a redox indicator can be used to compare the rate of respiration of yeast at different temperatures.

13 UNIT 6 STYLE

[3 marks]

In a yeast and methylene blue experiment, a student added a layer of oil to the surface of each tube. Explain why this improves the results, and suggest a suitable control.

[illegible]

Features of two muscle samples		
Feature	Muscle sample X	Muscle sample Y
Mitochondria	Many	Few
Myoglobin content	High	Low
Glycogen content	Low	High
Capillary density	High	Low

[illegible][illegible]

21 UNIT 5 STYLE

[3 marks]

A sarcomere in a relaxed muscle was $2.2\text{ }\mu\text{m}$ long. In the contracted muscle the length was $1.6\text{ }\mu\text{m}$. Explain what happens to the lengths of the A band, the I band and the H zone as the muscle contracts.

The heart, ventilation and exercise

Spec 7.12-7.15

A Level only

22 UNIT 5 STYLE

[5 marks]

Describe how the normal electrical activity of the heart coordinates the contraction of the atria and ventricles.

23 UNIT 5 STYLE

[1 mark]

Cardiac muscle is described as myogenic. What does this mean?

- A. ☐ It contracts only when stimulated by motor neurones.
- B. ☐ It contracts and relaxes rhythmically without nervous stimulation.
- C. ☐ It contains no myosin filaments.
- D. ☐ It is controlled only by hormones.

The table shows measurements taken from the ECG traces of two patients. Calculate the heart rate of patient 2, and deduce which patient has tachycardia. Show your working.

ECG measurements	
Patient	Time between two successive R peaks (s)
1	0.85
2	0.48

Answer = ...

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A patient's ECG shows an irregular, fast rhythm with no clear P waves. Suggest what this indicates and explain how an ECG helps in the diagnosis of abnormal heart rhythms.

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A person has a stroke volume of 80 cm³ and a heart rate of 65 beats per minute at rest. When exercising, their heart rate increases to 160 beats per minute and their cardiac output is 19 200 cm³ min⁻¹. Calculate (a) the resting cardiac output and (b) the stroke volume during exercise.

Answer = ...

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30 UNIT 6 STYLE**[4 marks]**

In a spirometer investigation, soda lime is placed in the circuit. Explain why, and give two precautions needed to keep the volunteer safe.

Homeostasis, hormones and the kidney

Spec 7.16-7.22

A Level only

31 UNIT 5 STYLE**[1 mark]**

Which part of the nephron is found mainly in the medulla of the kidney?

- A. ☐ Bowman's capsule
- B. ☐ Proximal convoluted tubule
- C. ☐ Loop of Henle
- D. ☐ Glomerulus

32 UNIT 5 STYLE**[4 marks]**

Explain the difference between negative feedback and positive feedback, and why negative feedback is important in homeostasis.

33 UNIT 5 STYLE**[4 marks]**

During vigorous exercise a person's core temperature rises. Describe how the hypothalamus brings about a return of the temperature to normal.

Compare and contrast how a steroid hormone and a peptide hormone alter gene expression in a target cell.

Describe how urea is made in the liver and how it is removed from the blood in the kidney.

The table shows the concentrations of substances in the blood plasma, in the glomerular filtrate and in the urine of a healthy person. Explain the differences between the plasma, filtrate and urine for protein, glucose and urea.

Concentration (g per 100 cm ³)			
Substance	Plasma	Glomerular filtrate	Urine
Protein	8.00	0.00	0.00
Glucose	0.10	0.10	0.00
Urea	0.03	0.03	2.00

37

UNIT 5 STYLE

[6 marks]

Explain how the loop of Henle acts as a countercurrent multiplier to increase the reabsorption of water.

38

UNIT 5 STYLE

[5 marks]

A person drinks very little water for a day and does not sweat. Explain how the changes in the blood are corrected by negative feedback.

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B: ATP is made by transferring a phosphate group directly from a substrate molecule to ADP.

2. [5]

- occurs in the cytoplasm
- glucose / hexose is phosphorylated using 2 ATP
- hexose biphosphate splits into 2 triose phosphate
- triose phosphate is dehydrogenated / oxidised, forming reduced NAD
- 4 ATP made by substrate-level phosphorylation, so net gain of 2 ATP
- 2 pyruvate formed per glucose
- Max 5

3. [4]

- pyruvate enters the mitochondrion / matrix
- pyruvate is decarboxylated, so CO₂ is removed
- pyruvate is dehydrogenated, hydrogen passed to NAD to form reduced NAD
- the acetyl group (2C) combines with coenzyme A to form acetyl CoA

4. [3]

- 2 pyruvate per glucose, so link reaction $2 \times 1 = 2$ and Krebs cycle 2 turns, $2 \times 3 = 6$
- $2 + 2 + 6$
- 10 (reduced NAD); award 3 marks for correct answer with no working

5. [5]

- reduced NAD / reduced FAD donate hydrogen / electrons to the chain
- electrons pass along carriers in redox reactions, releasing energy
- energy used to pump protons (H⁺) from the matrix into the intermembrane space
- proton gradient / high H⁺ concentration in the intermembrane space
- protons flow back through ATP synthase (chemiosmosis)
- energy used to join ADP and Pi to form ATP
- oxygen is the final electron acceptor, forming water
- Max 5

6. [3]

- pyruvate accepts hydrogen from reduced NAD
- so NAD is regenerated
- so glycolysis can continue to make (net) ATP by substrate-level phosphorylation

7. [4]

- lactate diffuses out of muscle into the blood
- carried to the liver
- converted (back) to pyruvate when oxygen is available
- pyruvate respired aerobically / enters link reaction and Krebs cycle
- or converted to glucose / glycogen
- oxygen debt repaid / extra oxygen taken in after exercise
- Max 4

8. [3]

- electron transport chain stops / electrons cannot be passed on
- reduced NAD and reduced FAD cannot be oxidised / NAD and FAD are not regenerated
- the dehydrogenation steps of the Krebs cycle need NAD / FAD, so the cycle stops

9. [1]

D D: 6CO_2 are produced for 6O_2 consumed, so $\text{RQ} = 1.0$.

10. [2]

- $\text{RQ} = \text{CO}_2 \text{ produced} \div \text{O}_2 \text{ consumed} = 38 \div 52$
- 0.73 (accept 0.7); no units

11. [3]

- lipids contain less oxygen (proportionally) than carbohydrates
- more oxygen is needed from outside to oxidise the lipid
- so volume of CO_2 produced is less than the volume of O_2 consumed / RQ is below 1

12. [4]

- yeast suspension and glucose in tubes at set temperatures in water baths
- add equal volume / concentration of redox indicator (methylene blue / DCPIP)
- measure time for colour to disappear
- rate = $1 \div \text{time}$; repeat and calculate means
- control variables: volume and concentration of yeast, glucose, indicator, pH
- Max 4

13. [3]

- oil prevents oxygen from dissolving / entering the suspension
- oxygen would re-oxidise the methylene blue / restore the colour
- control: boiled (and cooled) yeast, which should not decolourise the indicator

14. [5]

- volume $\text{O}_2 = \pi r^2 \times \text{distance} = \pi \times 0.4^2 \times 30 = 15.08 \text{ mm}^3$
- rate = $15.08 \div 10 = 1.5 \text{ mm}^3 \text{ min}^{-1}$ (1.51)
- net change = $\pi \times 0.4^2 \times 10 = 5.03 \text{ mm}^3$
- $\text{CO}_2 \text{ produced} = 15.08 - 5.03 = 10.05 \text{ mm}^3$ (or ratio 20 : 30)
- $\text{RQ} = 10.05 \div 15.08 = 0.67$ (accept 0.7)

15. [3]

- to allow for changes in temperature / atmospheric pressure
- so that fluid movement can be attributed to gas exchange by the woodlice
- KOH is corrosive: wear eye protection / keep it from touching the woodlice, or handle woodlice gently and return them to their habitat

16. [3]

- muscles can only pull / contract; cannot push
- biceps (flexor) contracts to bend the elbow while the triceps (extensor) relaxes
- triceps contracts to straighten the elbow while biceps relaxes
- bones act as levers, with the elbow as the pivot
- Max 3

17. [1]

B B: tendons join muscle to bone; ligaments join bone to bone.

18. [4]

- multinucleate / long cell surrounded by a sarcolemma
- contains many myofibrils / bundles of filaments running along the length
- myofibrils divided into sarcomeres (Z line to Z line) with thick myosin and thin actin filaments
- sarcoplasmic reticulum stores calcium ions
- T-tubules (folds of sarcolemma) pass into the fibre
- many mitochondria between myofibrils
- Max 4

19. [4]

- X is slow twitch (and Y fast twitch), because X has more mitochondria / myoglobin / capillaries
- slow twitch: many mitochondria for aerobic respiration, so ATP is made for a long time
- slow twitch: much myoglobin (stores oxygen) and dense capillaries supply oxygen, so the fibres resist fatigue / suit endurance or posture
- fast twitch: more glycogen for anaerobic glycolysis, so ATP is made rapidly
- fast twitch: contract faster / more forcefully, suited to sprinting, but lactate builds up so they fatigue quickly
- Max 4

20. [6]

- action potential causes sarcoplasmic reticulum to release Ca^{2+}
- Ca^{2+} binds to troponin, which changes shape
- this moves tropomyosin away from the myosin-binding sites on actin
- myosin heads bind to actin forming cross-bridges
- myosin head changes shape / power stroke, pulling actin past myosin
- ATP binds to myosin head, causing detachment from actin
- myosin ATPase hydrolyses ATP, releasing energy to re-set the myosin head
- ATP also used to pump Ca^{2+} back into the sarcoplasmic reticulum
- Max 6

21. [3]

- A band stays the same length because the myosin filaments do not change length
- I band gets shorter because the actin filaments slide inwards over the myosin
- H zone gets shorter / disappears because the actin filaments move closer together towards the centre

22. [5]

- SAN (in right atrium wall) initiates / generates a wave of excitation / depolarisation
- wave spreads across both atria, causing them to contract
- non-conducting tissue between atria and ventricles prevents the wave passing straight to the ventricles
- AVN delays the wave, so atria empty before ventricles contract
- wave passes down the bundle of His (in the septum) to the apex
- Purkyne fibres carry the wave up the ventricle walls, so ventricles contract from the apex upwards
- Max 5

23. [1]

B B: cardiac muscle contracts and relaxes rhythmically without nervous stimulation.

24. [3]

- heart rate = $60 \div 0.48$
- 125 beats per minute (accept 125 bpm)
- patient 2 has tachycardia because their heart rate is above 100 beats per minute (patient 1 = 71 bpm)

25. [3]

- atrial fibrillation / irregular atrial activity
- ECG records the electrical activity of the heart
- changes in the timing / spacing / shape of waves (e.g. R-R interval, P wave) can be compared with a normal trace to identify a rhythm problem such as tachycardia, bradycardia or ectopic beats

26. [3]

- resting cardiac output = $80 \times 65 = 5200 \text{ cm}^3 \text{ min}^{-1}$
- stroke volume = cardiac output $\div$ heart rate = $19\,200 \div 160$
- 120 cm^3

27. [5]

- respiration in muscles produces more CO_2
- CO_2 lowers blood pH / chemoreceptors detect the change
- impulses sent to the ventilation centre / cardiovascular control centre in the medulla oblongata
- ventilation centre sends impulses to the diaphragm and intercostal muscles, so breathing is faster and deeper
- impulses along the sympathetic nerve to the SAN increase heart rate
- so oxygen delivered faster to muscles / CO_2 removed faster
- Max 5

28. [4]

- adrenaline binds to receptors on target cells
- increases heart rate / stroke volume, so more oxygen and glucose delivered to muscles
- liver converts glycogen to glucose, raising blood glucose for respiration
- bronchioles dilate / ventilation increases, so more oxygen enters the blood
- blood redirected to muscles by vasodilation to them and vasoconstriction elsewhere
- Max 4

29. [5]

- rest: $0.50 \times 14 = 7.0 \text{ dm}^3 \text{ min}^{-1}$
- exercise: $1.80 \times 26 = 46.8 \text{ dm}^3 \text{ min}^{-1}$
- increase in oxygen consumption = $1.80 - 0.30 = 1.50$
- $(1.50 \div 0.30) \times 100$
- 500 (%)

30. [4]

- soda lime absorbs the CO_2 breathed out
- so the fall in volume of the trace is due to oxygen being used / so the volunteer does not rebreathe CO_2
- precautions, one mark each, max 2:
- sterilise / use a clean mouthpiece
- check the volunteer has no health problem (e.g. asthma, heart condition) before exercise
- volunteer can stop at any time / stop if they feel dizzy or unwell
- keep flames away from the oxygen
- Max 4

31. [1]

C C: the loop of Henle (the glomerulus, Bowman's capsule and proximal tubule are in the cortex).

32. [4]

- negative feedback: a change is detected and the response reverses / corrects it
- positive feedback: the response increases / amplifies the change
- negative feedback keeps the factor within narrow limits / around a set point
- so conditions remain suitable for enzymes / cells
- Max 4

33. [4]

- thermoreceptors in the hypothalamus detect the rise in temperature of the blood
- hypothalamus sends impulses to effectors
- sweat glands secrete sweat; evaporation of water takes heat from the skin
- vasodilation of skin arterioles, more blood near the surface and more heat lost by radiation
- temperature falls to normal, so response reduced (negative feedback)
- Max 4

34. [4]

- steroid is lipid-soluble and passes through the cell surface membrane
- binds to a receptor inside the cell; the complex acts as a transcription factor binding to DNA
- peptide hormone cannot cross the membrane; binds to a receptor on the cell surface
- activates a second messenger / cascade in the cell, which activates a transcription factor or enzyme
- similarity: both act through transcription factors that switch genes on or off, changing the proteins made
- Max 4

35. [5]

- excess amino acids are deaminated in the liver; amino group removed
- ammonia formed is converted to urea (ornithine cycle) which is less toxic
- urea carried in blood plasma to the kidney
- high pressure in glomerulus because afferent arteriole is wider than efferent arteriole
- urea and small molecules are filtered through capillary endothelium, basement membrane and podocytes into the Bowman's capsule
- Max 5

36. [4]

- protein absent from filtrate because too large to pass through the basement membrane
- glucose is the same in plasma and filtrate because it is small and filtered freely
- no glucose in urine because all of it is reabsorbed in the proximal tubule by co-transport / active transport
- urea is much more concentrated in urine because water is reabsorbed and urea is not (all) reabsorbed

37. [6]

- sodium and chloride ions are actively transported out of the ascending limb into the medulla
- ascending limb is impermeable to water, so water cannot follow
- medulla tissue fluid has low water potential
- descending limb is permeable to water, so water leaves by osmosis into the medulla
- filtrate is most concentrated at the bottom of the loop; fluid flows in opposite directions, maintaining a steep gradient along the whole length
- water then leaves the collecting duct by osmosis (when permeable), and is carried away by the blood capillaries
- Max 6

38. [5]

- blood plasma becomes more concentrated / lower water potential
- detected by osmoreceptors in the hypothalamus
- posterior pituitary gland releases more ADH
- ADH makes collecting duct walls more permeable to water (more aquaporins)
- more water reabsorbed by osmosis, so a small volume of concentrated urine is produced
- plasma concentration and blood volume return to normal, so less ADH is released
- Max 5